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Anthropogenic versus geogenic source determination of heavy metals in residential soils potentially impacted by metal smelting
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Smelting releases heavy metals (HM) into the environment and HM pollution is hazardous due to its effects on human health and the environment. Determination of soil background concentrations (those representing geogenic material) is necessary to assess potential risks associated with HM exposure. Here, data will be presented from thousands of soil samples collected from an urban residential environment (Site) to evaluate potential HM impact from nearby copper smelting. Chemistry of potentially impacted Site soils is compared with geogenic and mine-related sources. Due to the geologic/geochemical complexity of the Site, standard statistical methods are not sufficient to unravel anthropogenic and geogenic signatures in Site soils. This is partly due to incomplete characterization of mining-related potential source endmembers and the similarity between the geogenic and mining-derived soil components, both of which are elevated in arsenic, lead, copper, iron, and zinc. To distinguish geogenic from anthropogenic sources, we employ a multi-faceted approach utilizing machine learning (ML) tools (commonly applied in data science, but only recently regularly applied in environmental geochemistry) and myriad data types to recover a defensible background dataset. ML techniques are implemented to identify the most important data features controlling background and mining-related chemical characteristics. Preliminary results indicate that incorporation of ML tools with standard statistical techniques and other geochemical characterization data (e.g., chemistry, lithology, mineralogy) are invaluable to establishing background datasets and should be applied at other similarly complex sites. This multifaceted toolkit can build confidence in risk assessments, land-use planning, and environmental management practices.
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